

Attached are two spreadsheets providing our current cancer risk calculations associated with the HPNS radiological building RGs. The spreadsheets are not final; they are still undergoing internal review. The first spreadsheet provides risk estimates for the ingestion pathway of any residual contamination (i.e. the removable fraction); the second for external. The risk estimates are described as “bounding” estimates to reflect the conservative assumptions made in their calculation.

Risk via ingestion pathway (i.e., the removable fraction)

The ingestion calculations (first spreadsheet) assume a contaminated surface area of 32 m². They account for decay over the 26-year exposure period and daughter concentrations where appropriate (using +D DCFPAK slope factors). To be more protective and account for higher child ingestion rates, we have apportioned the ingested amount over the exposure period using 95th percentile values from the EPA Exposure Factors Handbook (Table 5-33) and the BPRG calculator 16 hour/day exposure assumption. This results in ingestion of virtually all of the contamination in the first 5 to 8 years of exposure. Even with these conservative assumptions, the ingestion risks associated with each of the 11 radionuclides are within the EPA risk range ($< 1 \times 10^{-4}$).

The Navy’s April RESRAD BUILD submittal calculates ingestion risk in a two-step conversion by applying dose conversion and cancer slope factors to RESRAD BUILD dose estimates. The submittal assumes decay and ingrowth (RESRAD BUILD model), a larger contaminated area (43 m² v 32 m²), and that ingestion occurs at a uniform rate over the 26-year exposure period (rather than at higher rates in early years).

Risk via external pathway

The external calculations (second spreadsheet) use EPA’s online BPRG calculator (decay and ingrowth accounted for) with the outputs adjusted to reflect a contaminated surface area of 32 square meters (reflecting the floor and lower walls). The adjustment factors were provided by Oak Ridge National Laboratory. We calculated risks for three different receptor locations within a room and included the highest exposure scenario (receptor positioned in the corner) in the summary tab. Other inputs are listed in the spreadsheet (e.g., concrete surfaces, 10 x 10’ room). We chose to set the amount of time spent indoors equal to one after considering the 95th percentile “time indoors” values in Table 16-1 in the Exposures Factor Handbook. (Using actual values from Table 16-1 would provide an average value slightly less than one but the difference is small.)

The Navy’s April RESRAD BUILD submittal calculates risk by applying dose conversion and slope factors to RESRAD BUILD dose estimates. The submittal assumes lower values than EPA assumed for amount of time spent indoors, in part because mean rather were used. The submittal accounts for radiation decay and ingrowth. The submittal assumes a receptor would be positioned in the center of the room. The submittal also assumes contaminated floor and lower walls with a slightly larger room size (12’ x 12’).

Total risk

The first tab in the ingestion spreadsheet provides the sum of the risks for the two exposure pathways. The total is less than 1×10^{-4} for most radionuclides; the exceptions are Cs-137, Co-60, and the two europium isotopes.

Here is a summary table of the estimated cancer risks for each ROC if present at the RG:

| Parent ROC | Bounding Ingestion Risk* | Bounding External Risk* | Bounding Total Risk* |
|-------------------|--------------------------|-------------------------|----------------------|
| ²⁴¹ Am | 5.29E-06 | 2.89E-07 | 5.6E-06 |
| ⁶⁰ Co | 5.14E-05 | 2.01E-04 | 2.5E-04 |
| ¹³⁷ Cs | 6.06E-05 | 1.37E-04 | 2.0E-04 |
| ¹⁵² Eu | 2.05E-05 | 2.13E-04 | 2.3E-04 |
| ¹⁵⁴ Eu | 3.51E-05 | 1.71E-04 | 2.1E-04 |
| ³ H | 1.26E-07 | 0.00E+00 | 1.3E-07 |
| ²³⁹ Pu | 6.57E-06 | 4.14E-09 | 6.6E-06 |
| ²²⁶ Ra | 1.95E-05 | 1.17E-05 | 3.1E-05 |
| ⁹⁰ Sr | 3.84E-05 | 2.34E-06 | 4.1E-05 |
| ²³² Th | 2.28E-05 | 5.81E-06 | 2.9E-05 |
| ²³⁵ U | 2.08E-05 | 8.36E-06 | 2.9E-05 |

Two key assumptions that would need to be verified during retesting are the removable fraction (< 20%) and the extent of contamination (< 32 m2). We are still wrestling with how the latter assumption would be verified, particularly the minimum MDAs needed to verify that an area greater than 32 m2 is not contaminated and contributing significant risk.